Compliance Time Determination

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FAA Public Meeting

Cessna 400 Series Wing Spar

Downtown Kansas City Marriott

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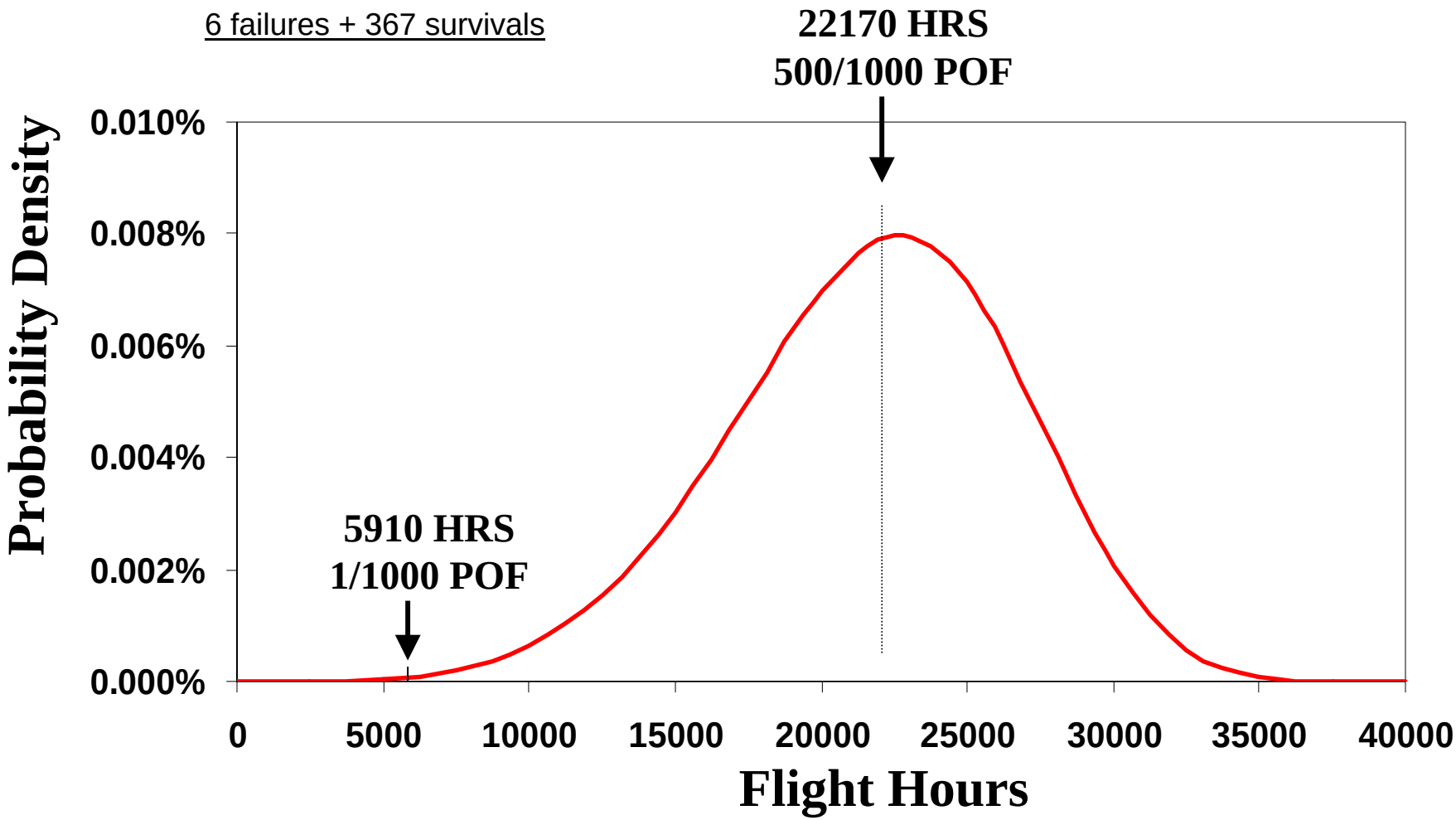
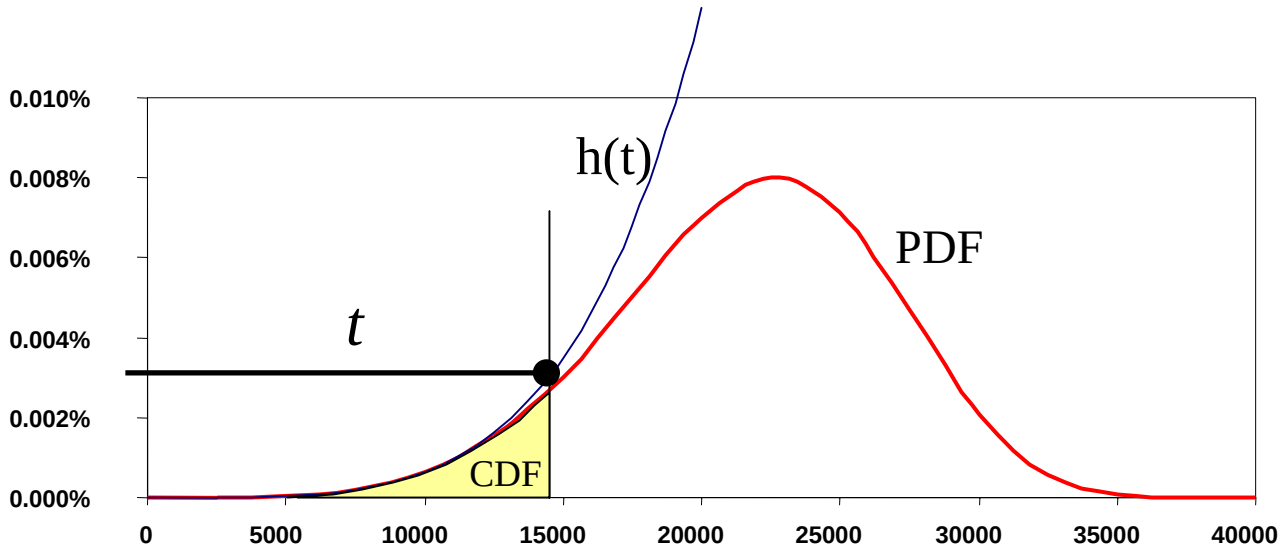
Overview

- Risk-Based Model
  - Relative failure probability
  - Relative short-term risk exposure
- Fleet Data
  - Failures, non-failures
  - Flight hour estimates
- Proposed Compliance Time Schedules
- Conclusions

Failure Probability Distribution



Hazard Function h(t)
instantaneous failure rate

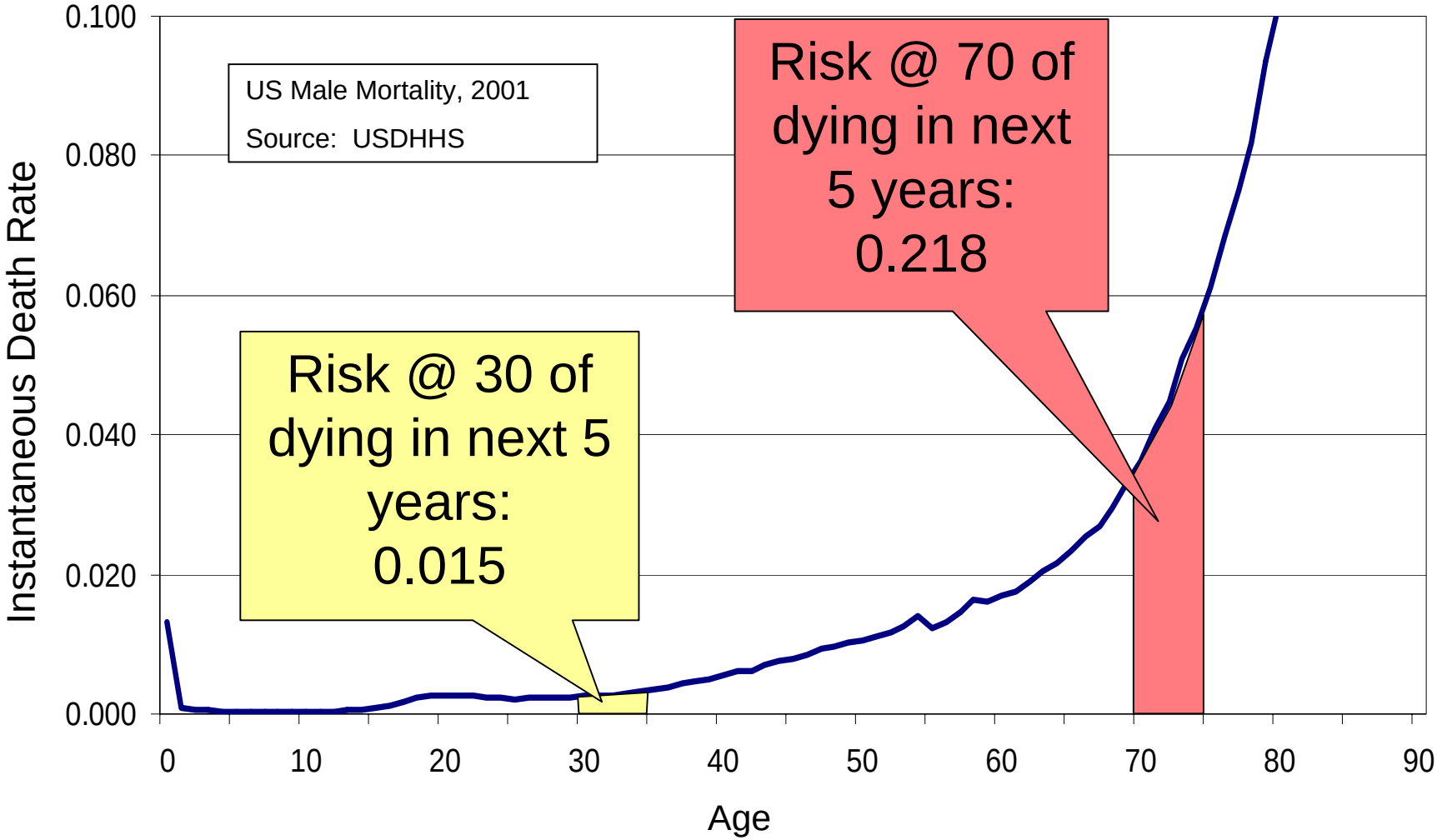


$$\text{Hazard Function } h(t) = \frac{\text{PDF}(t)}{1 - \text{CDF}(t)}$$

Interpretation:

- **Consider an individual aircraft found no failed spar at time t.**
- **The chances of finding a failed spar in a small interval [t, t+dt] are then given by $H(t) \cong h(t)\,dt$**

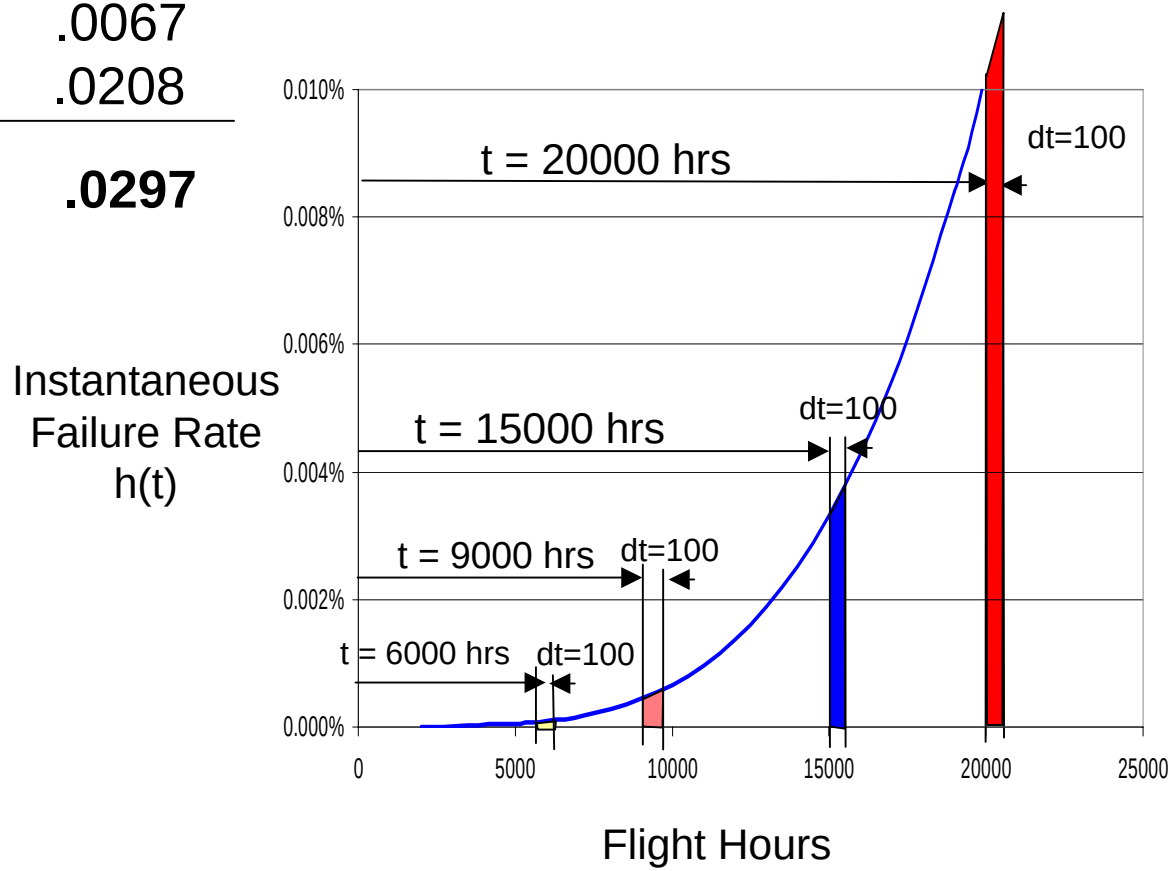
Analogy to Human Mortality



Example – Fleet of 12 Airplanes

No. A/C	Hours	h(t)*dt	H(t)
4	6000	.00009	.00036
4	9000	.00045	.0018
2	15000	.00335	.0067
2	20000	.01040	.0208
Fleet Total			**.0297**

Calculate hazard next 100 hrs



Important Parameters

- A/C flight hours
- Exposure time (time to compliance)
- Number of airplanes exposed

FAA must evaluate the Total Fleet Risk based on available data

Sanity Check…

"…the objectives of science in medicine are merely to set limits to our ignorance rather than providing us with certainty in all therapeutic decision-making."

--Baum, Houghton and Abrams; Statistics in Medicine; 13:1465, 1994.

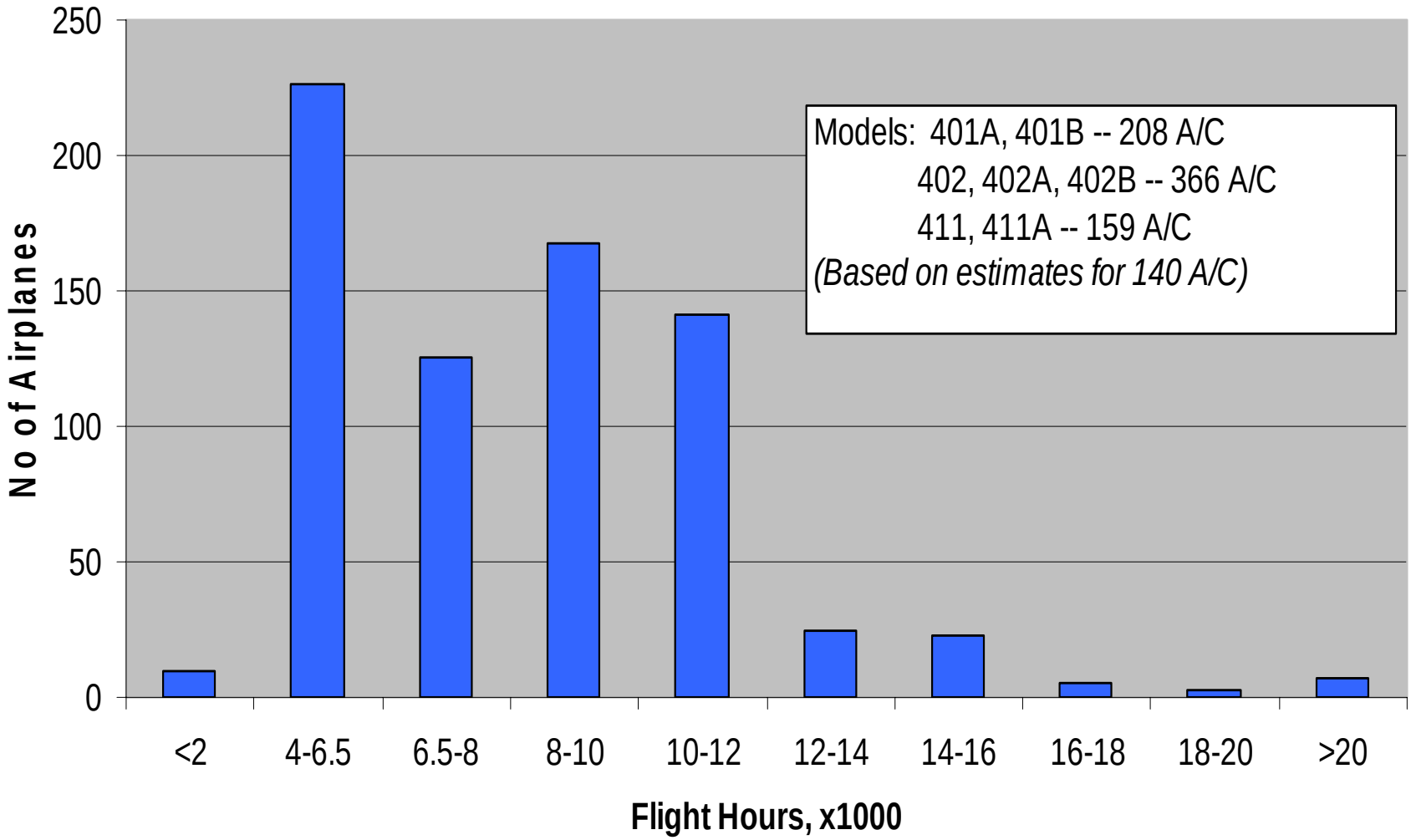
"…the objectives of risk assessment in engineering are merely to set limits to our ignorance rather than providing us with certainty in all engineering decision-making."

--Dr. Michael Shiao; Statistics in Engineering
FAA William J. Hughes Technical Center, June 16, 2004

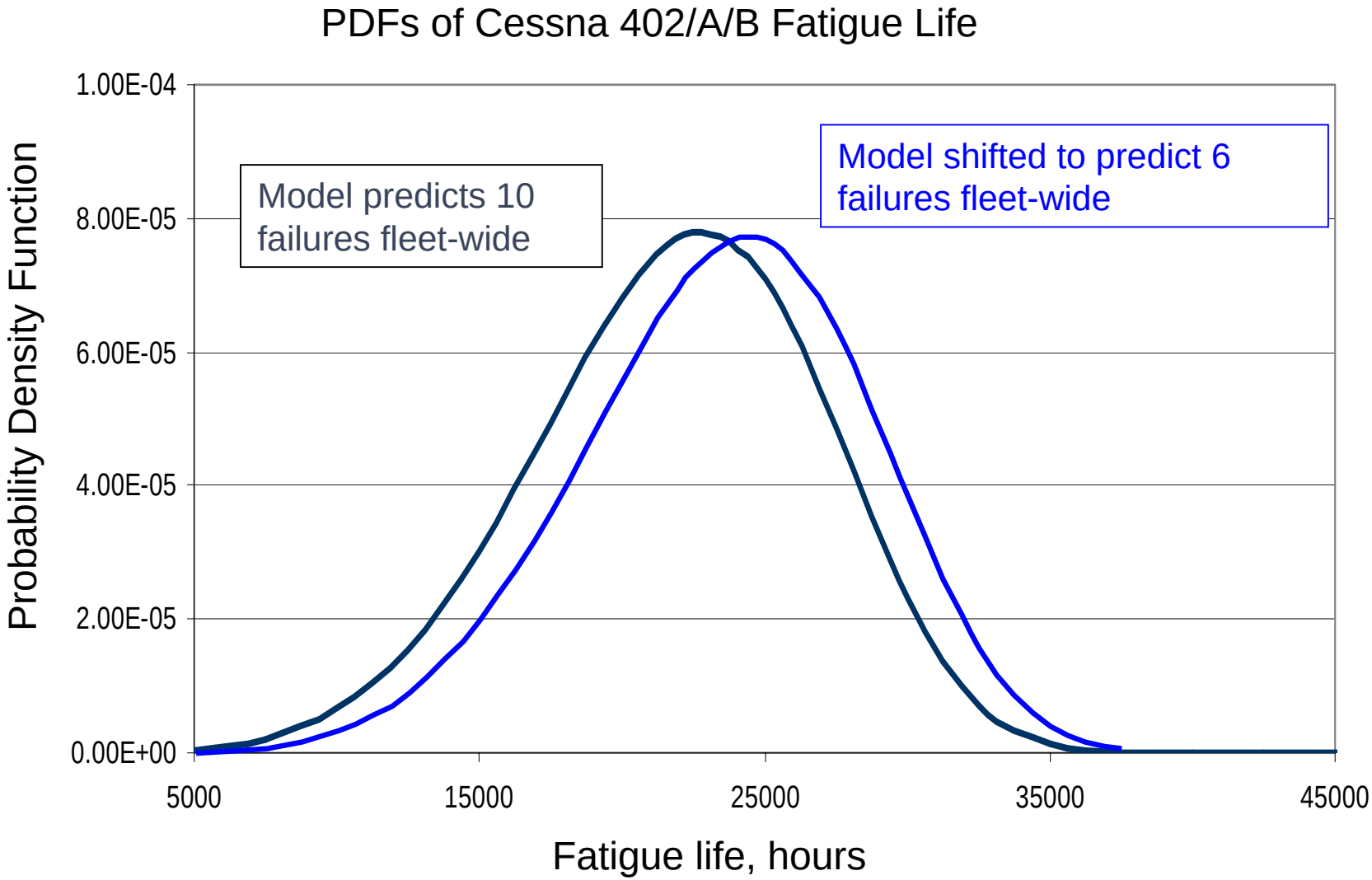
Apply Risk Model

1. Risk model based on 402, 402A, 402B
   - 6 failures, 367 non-failures
   - Estimated fleet hours distribution
2. Model calculations
   - 1/1000 failure at 5910 hrs
   - 10 failures fleet-wide
3. Calibrate model
   - “Shift” curve to reflect 6 failures fleet-wide
   - 1/1000 failure at 7500 hrs
4. Calculate hazard function curve

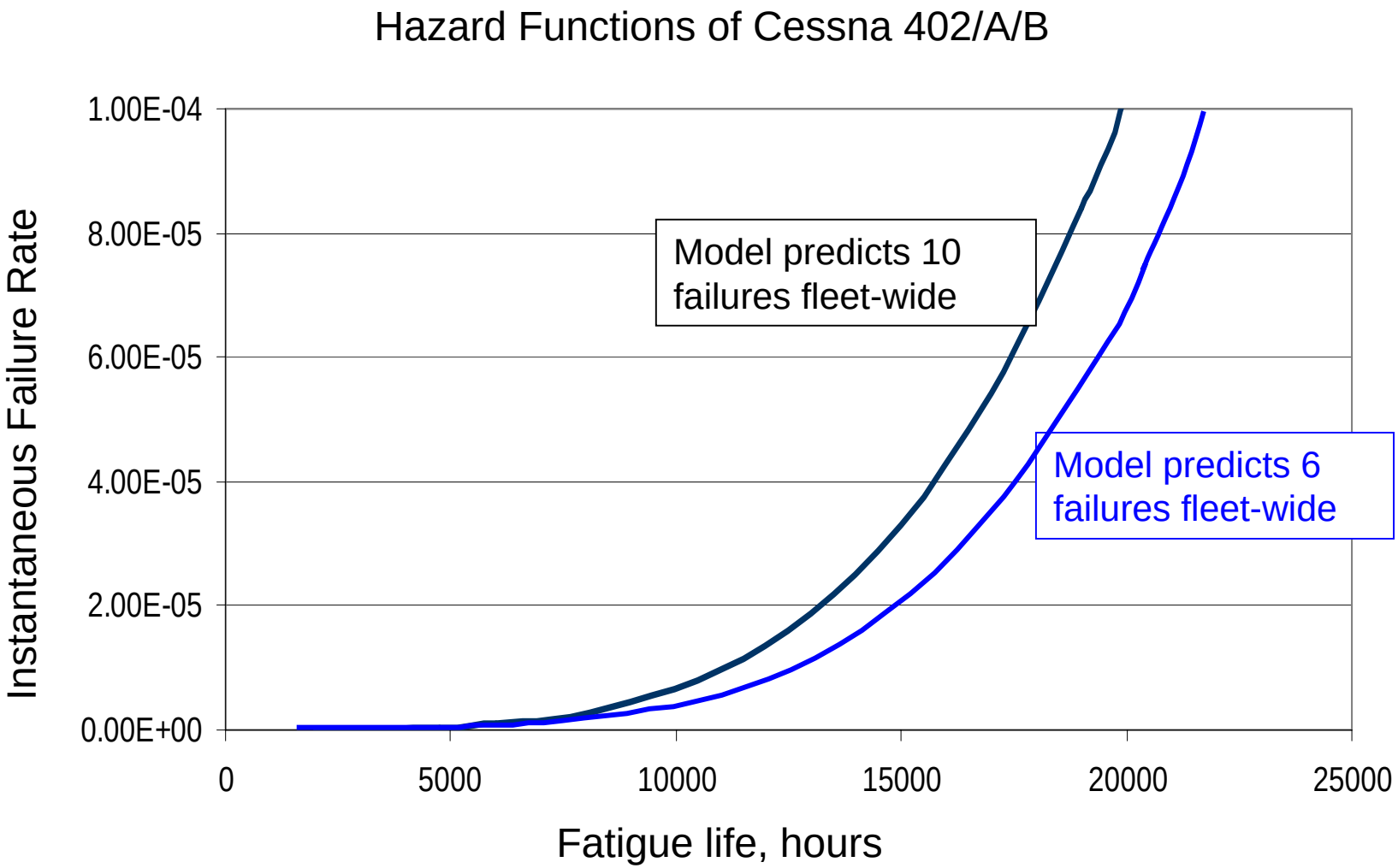
Estimated Fleet Flight Hours



Failure Probability Distribution



Hazard Function



Apply Risk Model

5. Calculate risk of doing nothing
6. Calculate risk for old compliance schedule
   - Apply to 401A, 401B, 402, 402A, 402B, 411, 411A
   - Modify @6500 hrs within 200 hrs (1 year)
   - Fleet = 733, Est A/C > 6500 hrs = 498
7. Calculate risk for alternative compliance schedule
8. Compare risk of failures before modification
9. Estimate A/C modification rate required

Compliance Schedule Alternative

Models Affected:

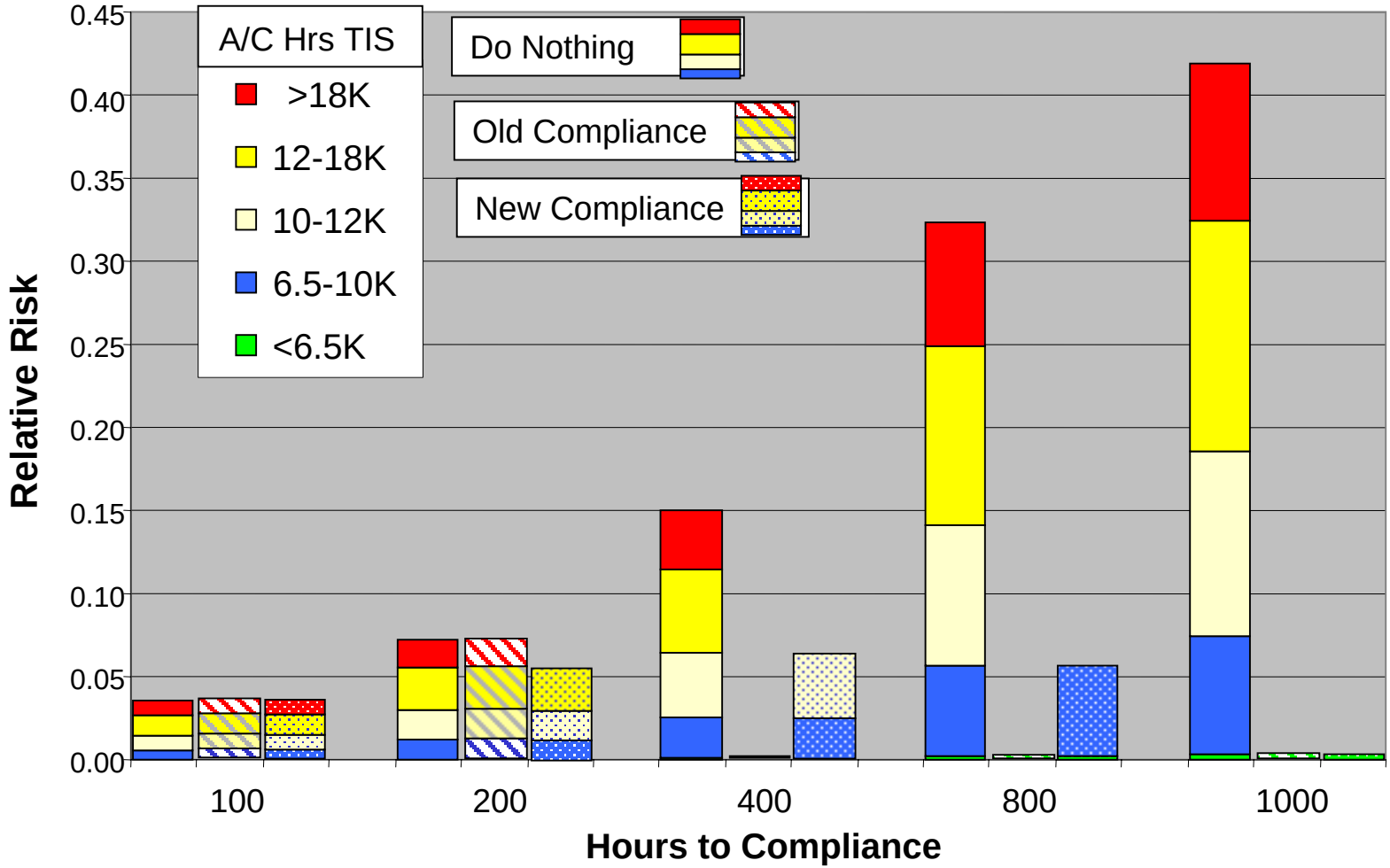
401A, 401B, 402, 402A, 402B, 411*, 411A*

A/C TIS (1000 hrs)	Compliance Time (hrs)	Est # A/C
>18	100	10
12-18	200	54
10-12	400	141
6.5*-10	800	293

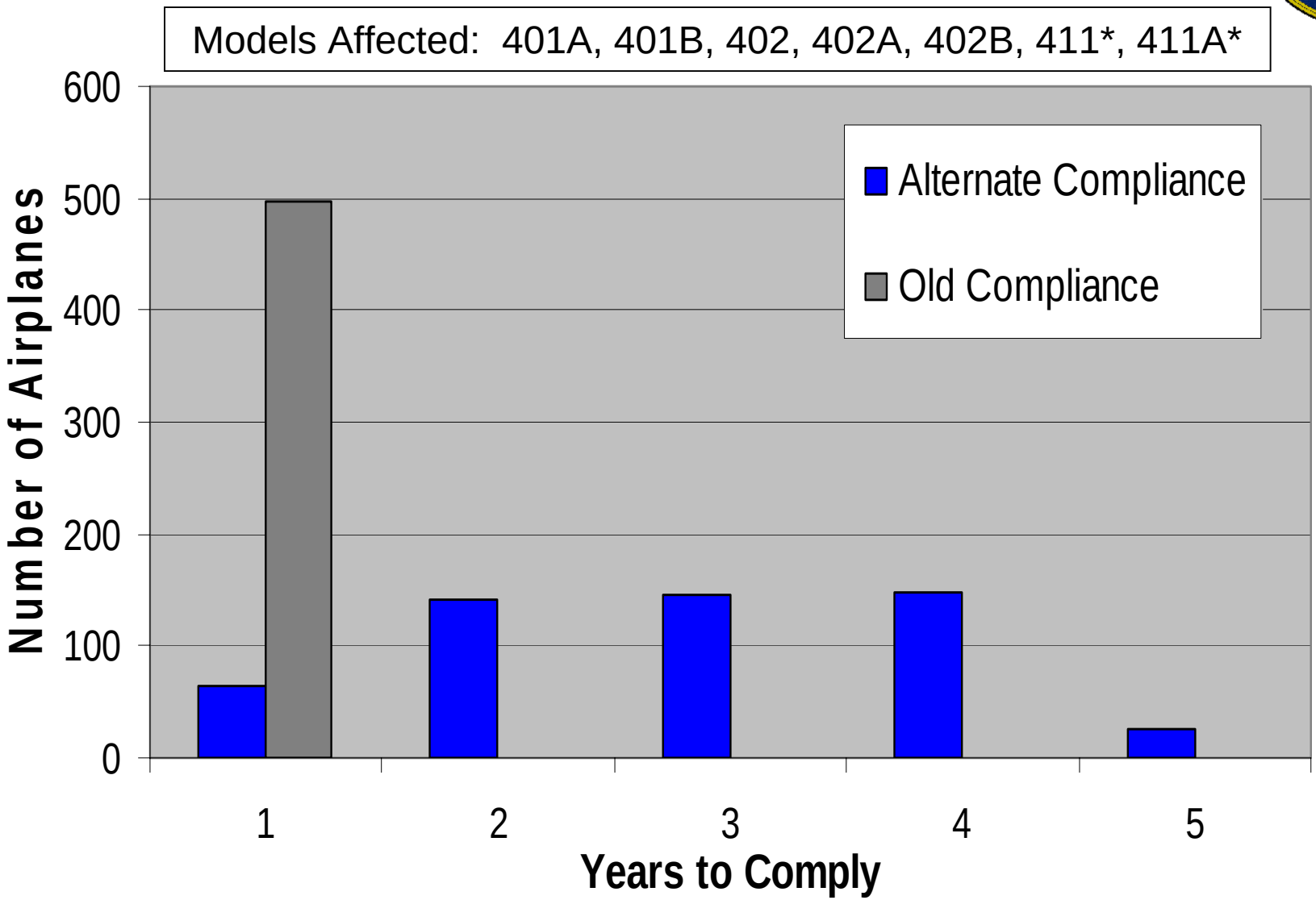
Minimizes immediate impact on low usage A/C

Compliance Risk Comparison

Models Affected: 401A, 401B, 402, 402A, 402B, 411*, 411A*



Required Mods Each Year



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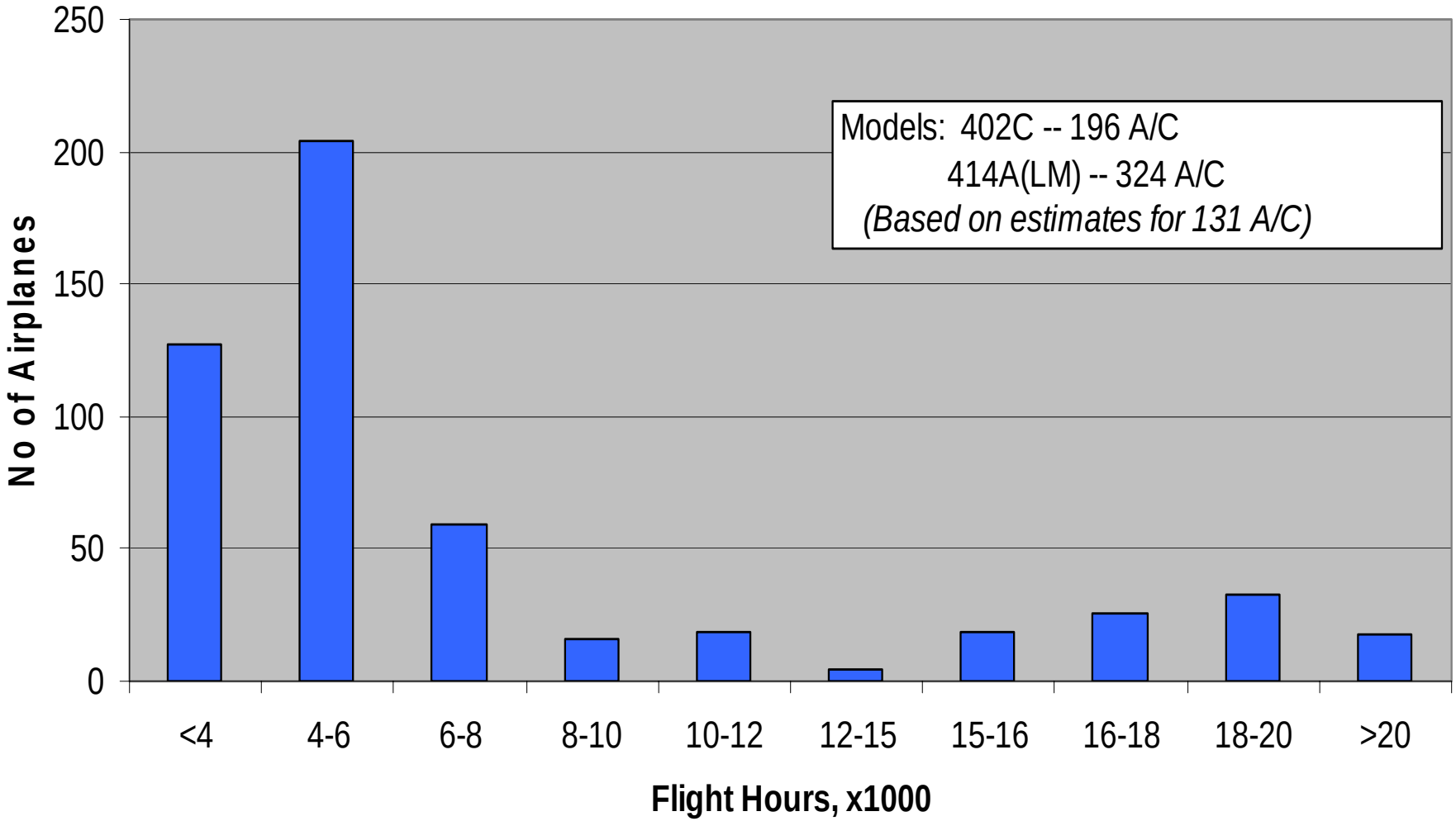
Minimizes immediate impact on low usage A/C

Apply Risk Model to 402C, 414A

1. Use hazard function curve from first analysis (402, 402A, 402B)
2. Calibrate model: shift curve to 1/1000 failure at 15000 hrs
3. Calculate risk of doing nothing
4. Calculate risk for old compliance schedule
   - Apply to 402C, 414A (late models)
   - Modify @15000 hrs within 500 hrs (1 year)
   - Fleet = 523, Est A/C > 15000 hrs = 94
5. Calculate risk for alternative compliance schedule
6. Compare risk of failures before modification
7. Estimate A/C modification rate required

Estimated Fleet Flight Hours – 402C/414A



Compliance Schedule Alternative

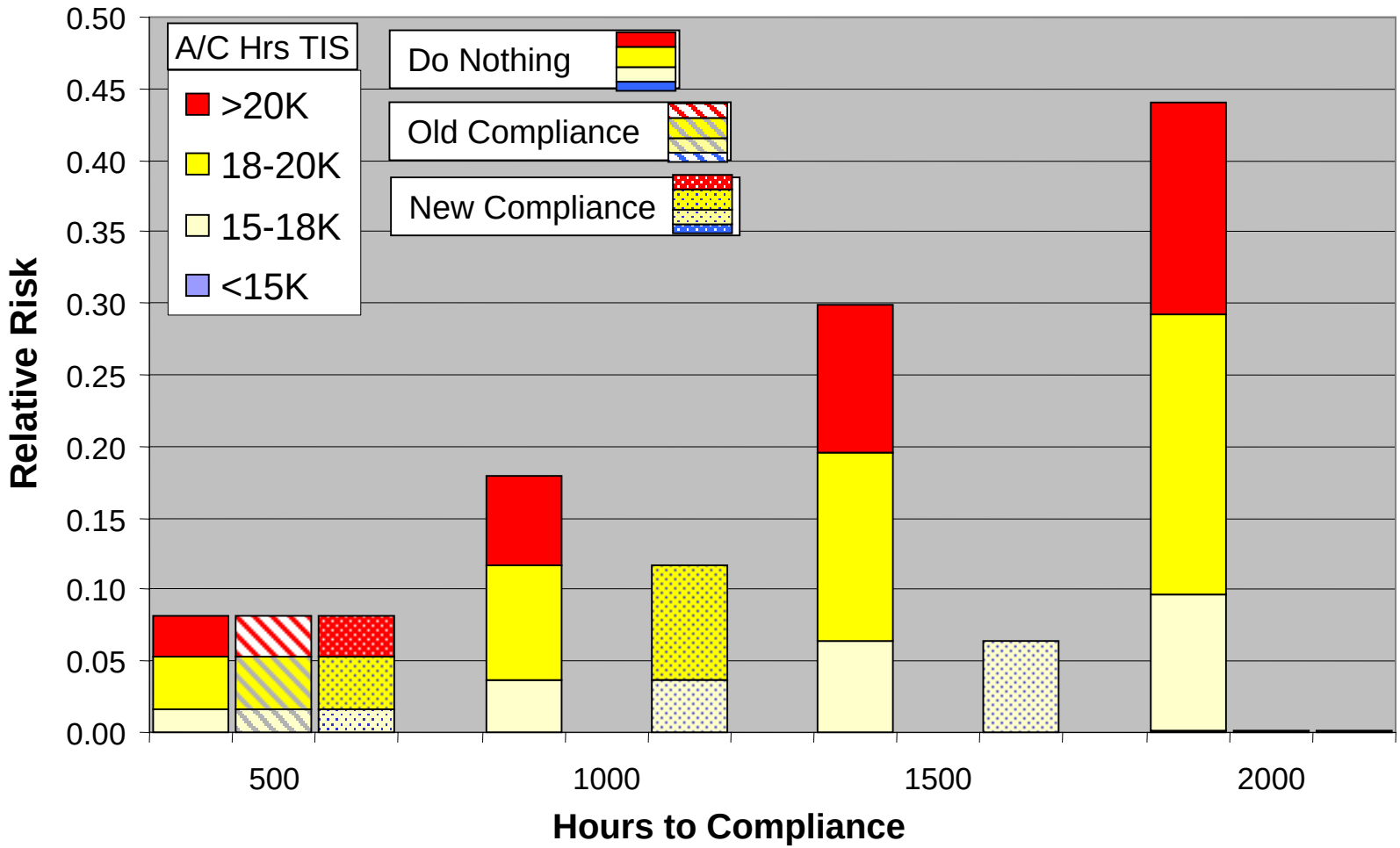
Models Affected: 402C, 414A (late models)

A/C TIS (1000 hrs)	Compliance Time (hrs)	Est. # A/C
>20	500	17
18-20	1000	33
15-18	1500	44

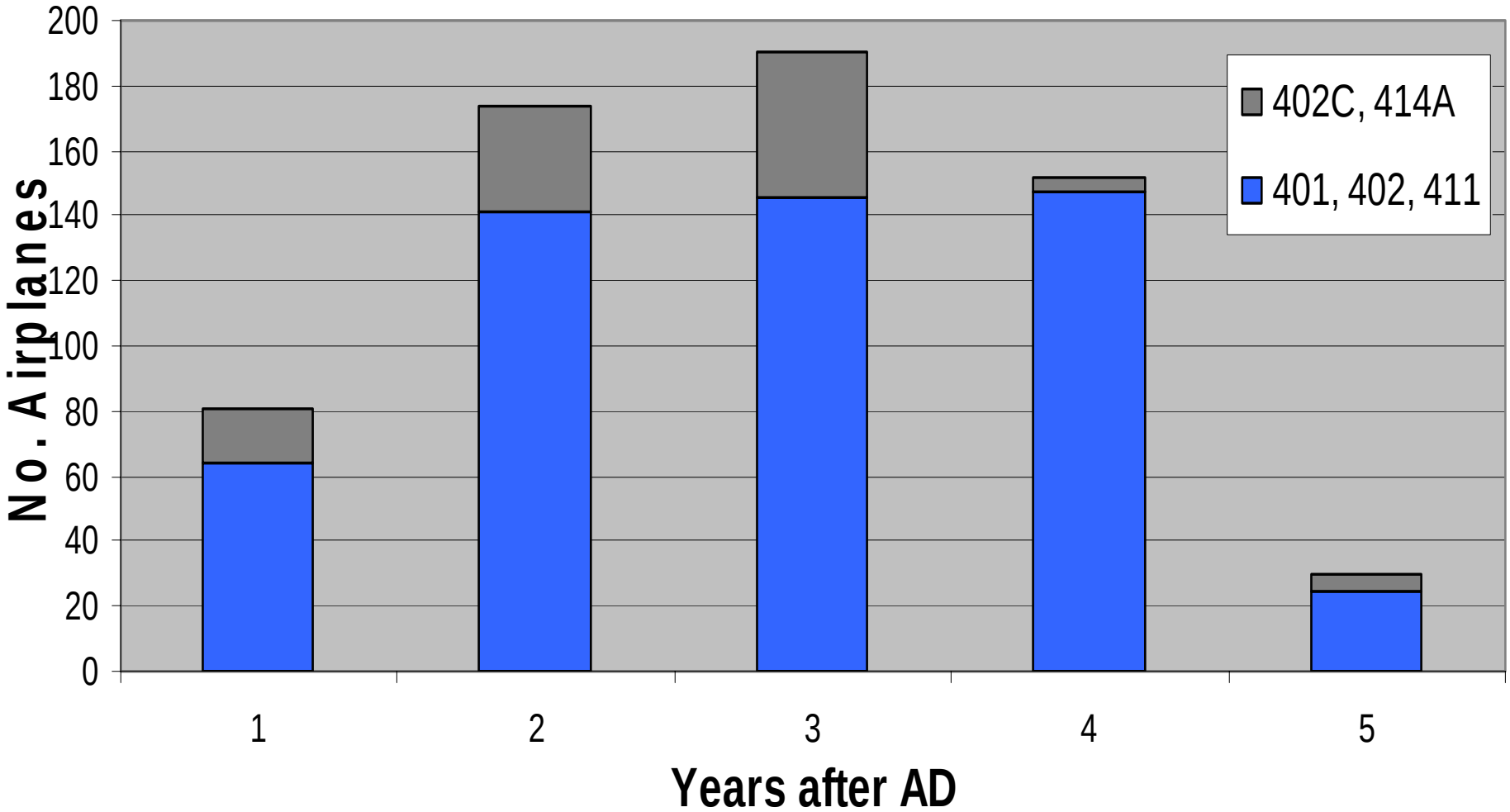
Minimizes immediate impact on low usage A/C

Compliance Risk Comparison

Models Affected: 402C, 414A (Late Models)



Required Mods Each Year (All Models)



Conclusions

- Model predicts relative short term risk
- FAA must act to mitigate fleet risk
- Compliance schedule based on evaluation of short term risk to fleet
- Concerns with no. of fleet mods in out-years
- Evaluation based on estimated fleet A/C hours

FAA's Next Steps

- Issue NPRMs by end 2004
- Examine any additional data
- Issue ADs by mid 2005
- Process potential AMOCs

Short Term Failure Probability P_F^{st} in A Given Interval dt